- # SECTION 9 RUNNING AND MAINTENANCE OF ENGINE
- **I. Key points for running of engine**
- 1. Check coolant level, refill coolant and check oil level, refill oil before starting.
- 2. Starting time is not more than 15 seconds for every time. The time interval between two starting is not less than 30 seconds.
- 3. After starting,the engine most run at the idling speed for 3~5 minutes, Don’t depress the accelerator violently before the oil pressure is higher than 2.0 bar and the temperature is higher than 60℃.
- 4. After the engine is out of ignition, operate it for 3~5 minutes at the idling speed, and then stop it. Don’t depress the accelerator violently befor stopping ignition.
- 5. Drive the first 3000 Km without a trailer and with only moderate loading of the engine, e.g. not over 70% rated total load.

Ⅱ. Maintenance

Table 2-11 Driving condition groups

WG I Group	WG Ⅱ Group	WG Ⅲ Group
Bad operation condition (severe winter, Hot summer, sandy or cross - country). Vehicles for short distance.Average an nual mileage: up to 20000 Km	Vehicles in short and medium distance service. Average annual mileage: up to 60000 Km	Vehicles is long distance service. Average annual mileage: over 60000 Km

	(WG Ⅰ)	(WG Ⅱ)	(WG Ⅲ)
First check	At road milage of 1,000 – 1,500 km or 30–50 h	At road milage of 1,500 – 2,000 km	At road milage of 1,000 – 2,500 km
P	At the interval of 5,000km or 150h	At the interval of 1 × 10 km	At the interval of 1.5 × 10 km
WD1	At the interval of 1 × 10 km or 300h	At the interval of 2 × 10 km	At the interval of 3 × 10 km
WD2	At the interval of 2 × 10 km or 600h	At the interval of 4 × 10 km	At the interval of 6 × 10 km
WD3	At the interval of 4 × 10 km or 1200h	At the interval of 8 × 10 km	At the interval of 12 × 10 km
WD4	At the interval of 8 × 10 km or 2400h	At the interval of 16 × 10 km	At the interval of 24 × 10 km

Table 2-12 Period in first check, routine inspection, maintenance

Note: ● indicates that oil replacement is needed

● P— Routine inspection

● WD1, WD2, WD3, WD4— 1, 2, 3, 4 class maintenance

	(WG Ⅰ)	(WG Ⅱ)	(WG Ⅲ)	Generator oil grade	
	Annual road mileage less than 2×10 km	Annual road mileage less than 6×10 km	Annual road mileage exceeding 6×10 km	API CD	API CF
First check	At road milage of 1,000 ~ 1,500km	At road milage of 1,500 ~ 2,000km	At road milage of 1,000 ~ 2,500km	●	●
P	At the interval of 5,000km	At the interval of 1×10 km	At the interval of 1.5×10 km	●	●
WD1	At the interval of 1×10 km	At the interval of 2×10 km	At the interval of 3×10 km	●	●
WD2	At the interval of 2×10 km	At the interval of 4×10 km	At the interval of 6×10 km	●	●
WD3	At the interval of 4×10 km	At the interval of 8×10 km	At the interval of 12×10 km	●	●
WD4	At the interval of 8×10 km	At the interval of 16×10 km	At the interval of 24×10 km	●	●

Table 2-13 Replacempnt period in maintenance
Note: ● indicates that oil replacement is needed
● P— Routine inspection
● WD1, WD2, WD3, WD4— 1, 2, 3, 4 class maintenance

Ambient air temperature		A	tropical or rigid climate (temperature often above +30℃ or below –10℃)
Use fuel with sulphur content of 0.5% (by mass)		B	Use fuel with sulphur content of 0.5%–0.1%
Use fuel with sulphur content less than 0.5%		C	Use fuel with sulphur content of 1.0%–1.5%
Oil replacement period		Supercharged diesel engine	
Normal conditions of use	WG Ⅰ	5,000	10,000
	WG Ⅱ	At the interval of 10,000 km	At the interval of 10,000km
	WG Ⅲ	1,500	30,000
Severe condition A	WG Ⅰ	5,000	10,000
	WG Ⅱ	5,000	10,000
	WG Ⅲ	5,000	10,000
Severe condition B	WG Ⅰ	5,000	1,000
	WG Ⅱ	5,000	1,000
	WG Ⅲ	10,000	15,000
Severe condition C	WG Ⅰ	5,000	10,000
	WG Ⅱ	5,000	10,000
	WG Ⅲ	5,000	10,000
Severe condition A+B	WG Ⅰ	5,000	7,500
	WG Ⅱ	5,000	7,500
	WG Ⅲ	5,000	10,000
Severe condition A+C	WG Ⅰ	2,500^	5,000
	WG Ⅱ	2,500^	5,000
	WG Ⅲ	2,500^	5,000

Table 2-14 Diesel engine oil replacement period (depending upon oil consumption)

Maintenance specifications of the diesel engine	Note	First check	P	WD1	WD2	WD3	WD4
Replace oil of diesel engine(diesel engine uses CD or CF oil)(at least once a year)		●	●	●	●	●	●
Replace oil filter or element		●	Every time when replacing diesel engine oil				
Check and adjust valve clearance		●		●	●	●	●
Check opening pressure of injection nozzle.						●	●
Replace fuel filter (inline type injection pump)				●	●	●	●
Clean fuel pump coarse filter				●	●	●	●
Check antifreezing fluid level and replenish		●	●	●	●	●	●
Replace antifreezing fluid							
Tighten cooling pipe clamp		●	At interval of 24 months				
Tighten intake pipe, hose and flange connecting parts		●		●	●	●	●
Check the maintenance indicator lamp of the air filter				●	●	●	●
Clean the dust pocket of the air filter (excluding automatic dust exhaust type)		●	●	●	●	●	●
Clean the air filter main element		When the indicator lamp comes on					
Replace the air filter main element		Refer to the relevant sections of the Operator′ s Manual					
Replace the air filter safety element		After the main element has been cleaned for 5 times					
Check and tighten the V-belt		●	●	●	●	●	●
Check the bearing clearance of the supercharger							●

Table 2-15 Maintenance specifications of the diesel engine

Maintenance specifications of the diesel engine	Note	First check	P	WD1	WD2	WD3	WD4
Check injection pump in a special workshop							●
Check and adjust the clutch travel and the steel cable condition		●	●	●	●	●	●
Adjust the idle speed		●					

Note: ● indicates that maintenance is needed.

- **3 . Oil and antifreezing fluid for engine use**
- WD615 series engines are comparatively advanced in the world in both power generation and economy, so they have some special requirements on the oil used by various mechanical parts. Misuse of oil may result in such serious failures as burning of bearing shell and break of shaft. So, it is very important to familiar with the requirement on oil and their use for each model of the engine.
- **I) Fuel**
- There are many physical and chemical properties indexes for diesel fuel, but the most important ones are the cetane number which reflects the combustion property and the solidification point which represents the fluidity. The higher the cetane number, the better the combustion property is. The selection of the cetane number depends on the rotating speed of the engine. High-speed diesel engines for modern trucks normally use diesel fuel of hexadecane 40. The number of the diesel fuel represents its solidification point. According to their solidification point, the diesel fuel is numbered as 10, 0, -10, -20, -35, or even -50. No.-10 indicates that the solidification point of the diesel is minus 10 degrees. To select what number of diesel fuel to be used depends on the ambient temperature of use. In general, the number of the diesel fuel to be used should be 5-10?C lowerer than the temperature of use.

- **2)Diesel engine oil**
- There are also many physical and chemical properties indicators for diesel engine oil. The number of the oil includes two indexes: oil strength (quality) grade index, and viscosity index. To select what number of diesel engine oil to be used depends on the integrated requirement of the engine on the two indexes mentioned above.
- Diesel engine oil is graded into AP1CA, CB, CC, CD, CF and etc. depending on their quality and strength according to the internationally accepted AP1 (American Petroleum Institute) standard. The higher the grade, the higher the strength and the better the quality of the oil is. The selection of the engine oil grade usually depends on the working strength and the severeness of the operating conditions of the diesel engine. The working strength of the diesel engine is represented by coefficient of intensification $K\phi$.
- $K\phi = Pe \cdot Cm \cdot Z$
- Where, Pe --- the mean effective pressure of the diesel engine (kg/cm2).
- Cm --- Mean piston speed (m/s).
- Z --- Stroke coefficient (four-stroke diesel engine Z=0.5, and two-stroke diesel engine Z=1).
- Cm = Where, N --- Diesel engine rated rpm
- S --- piston stroke (litre)
- Pe= (kg ／ cm) Where, M --- Diesel engine max. torque (kg/m);
- V --- Cylinder total volume (litre).
- In general, AP1CA oil should be used when $K\phi < 30$.
- APICB、CC oil should be used when $30 < K\phi < 50$.
- AP1D, CF oil should be used when $K\phi > 50$.

- According to the result of the calculation as per formula above, the coefficient of intensification KΦ of WD615.66、WD615.59, etc. supercharged inter-cooling diesel engine with power greater than 266hp has already exceeded 50. Therefore, CD or higher grade oil must be used, otherwise, failures such as pre-wear or burn of bearing shell may occur at a earlier time of use.
- According to the internationally accepted SAE(US Society of Automotive Engineers) standard, engine oil is usually graded as SAE5, 10W, 15W, 20W, etc. on the basis of -18 ℃ (°F)viscosity index, and as SAE10, 20, 30, 40, etc. on the basis of 90℃(210°F). The former are for winter use, and the latter for summer use. The bigger the number, the greater the viscosity of the oil is. Oil that can be used in both winter and summer is usually defined as SAE15W/40 (as an example), and complies with winter viscosity index of SAE15W and summer viscosity index of SAE40. Selection of engine oil viscosity grade depends on the ambient temperature of use without strict requirement. Fig. 2-54 shows a recommended relationship between oil number and temperature of use.

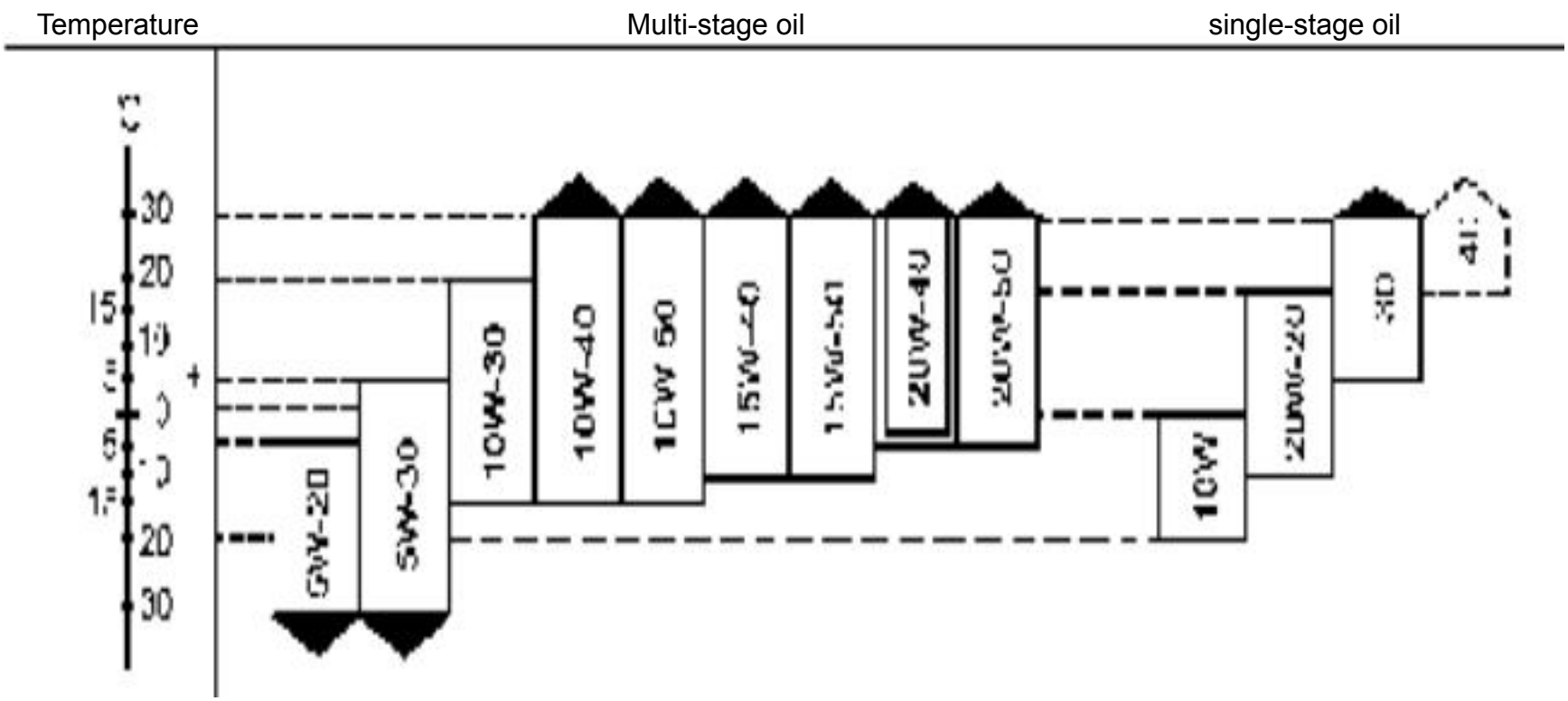

Fig. 2-54 Comparison between engine oil viscosity number and service temperature

SINOTRUCK (China National Heavy Duty Truck Group Co. Ltd.) requires that the WD615 series supercharged inter-cooling diesel engines use grade AP1.CD or CF, No. SAE15W/40 diesel oil for both winter and summer use.

- **3)Antifreezing fluid**
- Recommended antifreezing fluids for all year around use by STEYR truck engines.
- Most of antifreezing fluids used currently are ethylene glycol antifreezing fluids. Mixing the ethylene glycol with water at different volume ratio will make antifreezing fluids with different freezing points. The more ethylene glycol you put, the lower the freezing point of the antifreezing fluid is. Ethylene glycol antifreezing fluid is poor in volatileness, and stable in performance. But it is somewhat corrosive. So, it is better to use long acting antifreezing fluids produced by well-known manufacturers. Because anticorrosive agent is added in such antifreezing fluid, you often find that the cooling components of the engine such as the water tank, pipes, especially the pipe unions and cocks made of aluminum are seriously corroded. This is probably the consequence of the use of unqualified antifreezing fluids. As the Ethylene glycol is poor in volatilization, as long as there is no leakage in the cooling system, there is need to replenish any antifreezing fluid in use. It is only necessary to replenish some demineralized water when the water in the water tank is found dropped below the specified level. Before winter is coming, it is preferable to take some sample of the antifreezing fluid for examination of its freezing point, so as to avoid the occurrence of the accident of cylinders frozen because of defective antifreezing fluid.

Ser. No.	Engine fails to start	Remedy
1.	Fuel supply system failure: (1) There is air in the fuel supply system (2) Fuel pipeline blocked (3) Fuel filter clogged (4) Fuel supply pump does not supply fuel or supplies fuel intermittently (5) The injector injects very little fuel or does not inject fuel, or injection pressure is too low	(1) Check if the fuel pipe joint is loose and if the pipe is damaged. Loosen air bleed plugs on the fuel injection pump and the fuel filter, use a hand pump to suck fuel or pressurize the fuel tank to bleed the air in the fuel supply system. (2) Check if the pipeline is clear. (3) Wash fuel filter. (4) Check if there is air in the fuel inlet pipe. Otherwise, check and repair fuel supply pump.
2.	(6) Injection pump failed (7) Improper valve timing or angle of fuel supply commencement	(5) Remove the fuel injector but with it still connected to the high-pressure fuel pipe, use the starter to rotate the crankshaft and drive the injection pump plunger. Observe the condition of fuel injection and atomization, remove it for check and readjustment if necessary. (6) Check the plunger and fuel delivery valve, and repair or replace the damaged parts. (7)Check and adjust.
3.	Starting system failure: (1) Starting system is incorrectly wired or in poor contact	(1) Check the wiring condition and connect it properly.
4.	(2) Battery capacity is insufficient (3) Starter brushes and the commutator are in poor contact (4) Starter run idle	(2) Check battery capacity and recharge the battery. (3) Use fine sand paper to lap the commutator surface, blow off dust and replace brushes. (4) Check if the starter mounting and the friction clutch are normal.
5.	The engine can not be started with clutch pedal released, but can be started with clutch pedal stepped.	Check clutch and transmission.
6.	The compression pressure of the cylinder is insufficient:	(1) Replace piston ring.
7.	(1) Piston ring is worn excessively	(2) Check valve clearance, valve spring, and the tightness between the valve and the valve seat, lap the valve if the annular contacting zone is incontinuous.
8.	(2) Valve leaks	Use specified lubricating oil.
9.	Engine lubricating oil viscosity too great, and the crankshaft is difficult to rotate when temperature is low	Use specified fuel.
	Fuel specifications is incorrect	Reposition gear ring; replace flywheel and gear ring; spot weld gear ring on the flywheel.
	Flywheel gear ring is loose	(l) Clean the clog. (2) Wash air filter.
	Air intake is difficult: (l) Air inlet blocked (2) Fuel filter clogged	
	Ambient temperature and engine temperature too low	Correctly use cold starting system.

II. Engine Power Insufficient

Ser. No.	Failure cause	Remedy
1.	Valve spring is broken	1. Check and replace valve spring.
2.	Valve timing or fuel supply timing is incorrect	2. Calibrate the opening and closing angle and fuel supply advance angle of the intake and exhaust valves, check if the injection pump screw is loose, and tighten the screw if it is loose.
3.	Intake or exhaust valve clearance is incorrect	3.Check and adjust valve clearance.
4.	Cylinder compression pressure is insufficient, piston ring jammed, valve stem seized or	4.Clean, check and repair
5.	inflexible	5. Check and cool.
	Engine is overheated (cooling system or lubricating	6. Remove the cylinder head, remove the carbon deposit, and find out the reason of carbon deposit.
6.	system failed, water temperature is too high)	7. Wash the air filter, and check if its oil level is normal.
7.	Carbon deposit in the engine is too much	8. Check the intake and exhaust pipes, and remove the accumulated dirt.
8.	Air filter is clogged	9．Bleed the air from the fuel supply system by using the method mentioned above, and tighten or repair the fuel pipe joint
9.	Intake or exhaust pipe is clogged	10．Check the condition of wear, adjust the fuel injection pump, replace the plunger or fuel delivery matching parts if necessary, adjust the extra-low speed change of the Governor.
10.	There is air in the fuel supply system, or the system	11. Check and adjust the injection pump, and replace the needle valve matching parts
11.	leaks fuel	12.
12.	Injection pump failed	(1) Replace copper shim
13	Injection pump is clogged or in poor atomization	(2) Clean copper shim seat hole surface
	Cylinder head fuel injector seat hole leaks air:	(3) Tighten injection pump needle valve fixing sleeve or lap the mating and pressure-bearing surface
	(1)Copper gasket contacting surface is damaged	13．
	(2)Copper gasket seat hole is not well cleaned	• Tighten the bolt to specified torque.
14.	(3)The mating and pressure-bearing surfaces between the needle valve seat body and the injector body leaks	• Check the mating surfaces of the cylinder head and the cylinder block, replace the cylinder gasket (do not use or repair the gasket that should be discarded), and plane the mating surface of the cylinder head or the cylinder block in necessary.
	The joint between the cylinder head and the cylinder block leaks (its symptom is that, when changing rotating speed, there is a stream of airflow coming out from the gasket)	• Check and repair
	(1)Cylinder head bolt is loose	14．Remove any sticking substances and repair
	(2)Cylinder gasket is damaged (leaks air or water)	
	(3)Cylinder head or cylinder block plane surface deformed	
	Intake or exhaust valve is stuck to valve guide	

Ser. No.	Failure cause	Remedy
15. 16. 17. 18. 19. 20. 21. 22. 23. 24.	Supercharger is damaged or burnt Intake manifold leaks air Exhaust manifold leaks air Inter-cooler leaks air Air intake system pipe fitting leaks air Exhaust system pipe fitting leaks air Smoke limiter air pipe leaks, diaphragm is damaged Fuel quality is poor Oil pan oil level is too high Cylinder gasket leaks air	15．Remove and check the supercharger, and replace if necessary. 16．Check for air leakage, replace seals. 17．Check for air leakage, replace seals. 18．Check and repair the inter-cooler. 19．Check for air leakage, replace seals. 20．Check for air leakage, replace seals. 21．Replace air pipe joint, check and repair seals, replace diaphragm 22．Replace. 23．Check oil stick, drain out excessive oil. 24．Check the compression pressure when engine is still hot, and replace the cylinder gasket
25. 26.	Piston ring is worn or fractured, bearing shell clearance is too big Cylinder sleeve or piston is serious worn	25. Replace the worn part 26. Overhaul the engine

III. Engine generates abnormal noise

Ser. No.	Fault signature	Cause	Remedy
1.	Silvery metal knocking sound can be heard from inside the cylinder	1. Fuel supply is too early. 2. Fuel supply is too late.	1. Readjust the fuel supply timing. 2. Readjust the fuel supply timing.
2.	Deep and unclear sound can be hear from inside the cylinder	3. The mating between the piston pin and the connecting rod small end pin hole is too loose.	3. Replace the connecting rod small end bushing, so as to set the clearance within its specified range.
3.	There is low and sharp sound while the engine is running. The sound is clear at high speed.	4. The clearance between the piston and the cylinder is too big.	4. Replace the piston or replace the piston and the cylinder liner according to the state of the wear.
4.	Knocking sound can be heard when the engine is started. The sound becomes lower as the engine becomes warmer.	5. The connecting rod bearing shell is too loose or clearance is too big.	5. Check the connecting rod bearing shell, and replace if necessary.
5.	When the engine is accelerated abruptly, clear knocking sound can be heard continuously. The sound remains unchanged when engine temperature changes.	6. The crankshaft main bearing shell is too loose or clearance is too big.	6. Check the main bearing shell, and replace if necessary.
6.	While the engine is running at medium speed, deep knocking sound can be heard from the main bearing. The sound becomes more powerful when the rotating speed changes.	7. The axial clearance at the rear end is too big due to wear of the thrust plate, resulting in fore and aft movement of the crankshaft.	7. Replace the thrust plate.
7.	When the engine is at idle speed, sharp and moving sound can be heard from the fore and aft end of the crankshaft.		

Ser. No.	Fault signature	Cause	Remedy
8. 9. 10.	Low and rhythmical sound can be heard from the engine cylinder head. When the engine is running, powerful, smooth and rhythmical sound can be heard from the cylinder head. Hold the valve chamber cover with your finger lightly and you can feel that the piston is knocking at the valve or the cylinder head. Abnormal sound can be heard from the linkage gearbox cover plate. When the engine is decelerated suddenly, impact sound can be heard.	8. The valve spring is broken, the valve push rod is bent, or the lifter moving pairs are worn. 9. The piston collides with the valve or the cylinder head. 10. The gear is worn excessively, the gear backlash is too big, or the gear is damaged.	8. Replace the spring, push rod or lifter guide. Adjust the valve clearance. 9. Remove the valve chamber cover, and find out the cause of collision. Adjust the valve clearance, and if necessary, remove the cylinder head and find out the cause of colliding against the cylinder. 10. Adjust the gear clearance , and replace the gear if necessary.

IV. Abnormal smoke color of engine exhaust

When the engine is running under normal load, the exhaust smoke is generally in light-gray color. It is abnormal when the exhaust smoke is black, blue or white in case that the engine is lightly overloaded.

Ser. No.	Fault signatures and causes	Remedy
1.	Black smoke: • Fuel supply is too much, air is insufficient or load is too heavy. (2) Fuel injection by the injection pump to various cylinders is not even. (3) Injection pump is poor in injection. (4) Valves or piston rings are leaking. (5) Fuel injection is too late, part of the fuel is burning in the exhaust pipe. (6) Air intake is blocked or exhaust is under back pressure. (7) Fuel quality is poor. (8) The supercharging system is insufficient in pressure. (9) The supercharger is working abnormally. (10) Inter-cooler leaks air. (11) The action point of the smoke limiter is incorrect.	1. • Adjust the fuel supply and the valve clearance, and wash the air filter, or reduce the load. (2) Adjust the fuel supply to various cylinders, and make them balanced. (3) Check and repair the fuel injector. (4) Check the valve clearance, valve spring, valve sealing condition and the piston ring wearing condition. (5) Adjust the fuel supply advance angle. (6) Clean. (7) Replace. (8) Remedy the leakage. (9) Replace. (10) Remedy the leakage. (11) readjust.
2.	White smoke: (1) The injector leaks, the atomization is poor, injection pressure is low. (2) The engine is too cold. (3) There is water in the fuel.	2. (1) Check the sealing condition of the needle valve matching parts and the injection pressure, replace the needle valve matching parts and adjust the injection pressure. (2) Check and repair the cooling system and improve the heat preservation of the engine. (3) Replace fuel or remove water in the fuel tank and air filter.
3.	Blue smoke: (1) The air filter is clogged, airflow is not smooth, or the level of oil in the oil pan is too high, the airflow brings in too much oil.	3. (1) Check and clean the air filter, lower the oil in the oil pan to the specified level.

Ser. No.	Fault signatures and causes	Remedy
3	(2) The piston ring is seized or excessively worn, its elasticity is poor, letting oil enter the combustion chamber. (3) The valve timing or fuel supply timing are incorrect. (4) The compression pressure is low, fuel burning is incomplete and the piston bulges the cylinder. (5) The piston ring and the cylinder liner are not well fit. (6) The piston ring gaps are not properly staggered. (7) Oil rings are out of function. (8) The seal ring and the thrust bearing of the supercharger are worn. (9) The oil return pipe is blocked.	(2) Wash the piston rings, and replace if necessary. (3) Check and adjust. (4) Check and repair the piston rings and cylinder liner. (5) Continue to fit in. (6) Adjust. (7) Replace. (8) Replace. (9) Wash or repair.

V. Engine overheating

Ser. No.	Failure causes	Remedy
1.	Antifreezing fluid is insufficient.	1. Replenish antifreezing fluid to specified level (check and adjust the specific gravity of the antifreezing fluid in the winter).
2.	Oil is insufficient.	2. Replenish oil to specified level.
3.	The engine is overloaded.	3. Reduce engine load for cooling.
4.	The radiator is clogged by scale deposition and its exterior is dirty.	4. Clean its interior and exterior.
5.	The water pump drive belt is loose, the water pumpage is too small.	5. Adjust the tightness of the belt or replace it.
6.	The thermostat is out function.	6. Check, repair or place the thermostat.
7.	The water pump impeller is damaged.	7. Replace the impeller.
8.	Silicone oil fan is defective.	8. Screw in the lock pin so as to lock the drive and driven discs of the fan, and return the silicone oil fan to the factory for repair.
9.	Water pipe is damaged, and air comes in.	9. Check and replace.

VI. Unexpected engine flameout

Ser. No.	Failure causes	Remedy
1.	Fuel is exhausted.	1. Refuel.
2.	There is air in the fuel supply system	2. Check if the fuel pipe joint is loose, pipe is fractured, and remedy the defects and remove air in the system.
3.	Fuel filter or fuel pipe is clogged.	3. Disassemble and wash the filter element, and clear the fuel pipeline.
4.	There is water in the fuel.	4. Replace fuel or remove water in the fuel tank and air filter.
5.	Fuel supply pump does not work.	5. Check the fuel supply pump and remove any trouble.
6.	The piston is seized (due to engine overheating or too small clearance between the piston and the cylinder liner).	6. Use a crowbar to rotate the crankshaft first, wait until the temperature drops, and check the cooling system, the piston and the cylinder liner, and remove any troubles found.
7.	Idle speed is too low.	7. Readjust.
8.	Ignition switch leaks.	8. Replace

VII. Engine oil has no pressure, or pressure is too low or too high

Ser. No.	Failure causes	Remedy
1.	Pressure is adjusted improperly.	1. Adjust pressure.
2.	Oil pump gear is worn.	2. Repair or replace oil pump.
3.	Oil pipeline leaks, or is clogged, fractured or broken.	3. Check and repair oil pipe, or replace if necessary.
4.	Oil pressure limiting valve spring is damaged, and the valve mating surface is not smooth.	4. Replace spring, lap the mating surfaces of the pressure limiting valve, adjust the pressure.
5.	Oil radiator or oil filter is clogged.	5. Clear the oil radiator, replace oil filter element.
6.	The joints of oil pressure and temperature sensors leak oil.	6. Check, repair or replace.

VIII. Oil temperature is too high, oil is too thin and oil consumption is too high

Ser. No.	Failure causes	Remedy
1.	Oil temperature is too high: the engine is overloaded (with black exhaust smoke), or oil radiator is clogged.	1. Reduce the load or clear the oil radiator 2. Use specified oil. 3. Clean carbon deposit or replace oil ring. 4. Wash or replace piston ring, or replace piston and cylinder liner if necessary.
2.	Inappropriate oil is used.	
3.	Oil ring return hole is clogged by carbon deposit or the oil ring is jammed, and as a result, it lost the function of oil scrabbing.	
4.	The piston ring is stuck or worn too much against the cylinder liner, allowing oil to get in the combustion chamber and gas to come into the crankcase. Exhaust smoke is blue, and there is smoke coming out of the oil filler port and the ventilator of the crankcase.	

IX. Oil pan oil level rises

The main reason is that there is cooling water entering the oil pan. The oil with water is characterized in yellowish milky foam.

When checking, take some oil and put it in a glass, leave the glass undisturbed for 1 hour, and see if there is any water settled at the bottom of the glass. If there is water, replace the oil or get rid of the water from the oil, and remedy the trouble.

Ser. No.	Failure causes	Remedy
1. 2. 3.	Cylinder gasket is damaged. Cylinder head cracks (there is a lot of water in the exhaust gas, and water condensation makes the exhaust become white smoke). There is air pocket in air cylinder block, and as a result, it leaks water.	1. Replace cylinder gasket. 2. Repair or replace cylinder head. 3. Replace cylinder liner.

X. Too much fuel consumption

1. Air intake is blocked (air filter clogged).	1. Check and clear air filter and intake pipe.
2. Exhaust back pressure is too high.	2. Check and clear exhaust pipe and brake valve.
3. Fuel quality is poor.	3. Use specified fuel.
4. Fuel pipeline leaks.	4. Check and repair.
5. Fuel pipeline leaks.	5. Check and repair.
6. Injector is poor in atomization.	6. Check and adjust or repair.
7. The valve timing or fuel supply timing is incorrect.	7. Adjust the valve clearance and the fuel supply advance angle as specified.
8. The cylinder is hot and leaks.	8. Check compression pressure.
9. Bearing shell clearance is too big, and engine needs overhaul.	9. Check and overhaul.
10. Piston bulges the cylinder.	10. Replace cylinder liner, piston and piston rings.
11. The supercharging system is insufficient in pressure.	11. Check and remedy the leakage of the pipeline and the pipe connection.
12. The supercharger is working abnormally.	12. Check and replace the assembly.
13. Inter-cooler is damaged or leaks air.	13. Replace or repair.

XI. Unstable rotating speed

1. Fuel is poor in quality, contains water or wax.	1. Check fuel system, and replace fuel.
2. Air leaks into fuel inlet.	2. Check the sealing of fuel pipe and joint, and remove air from the fuel.
3. Governor weight and spring are working abnormally.	3. Check and repair (by special factory).
4. Fuel supply is non-uniform.	4. Check and adjust (by special factory).
5. Injection nozzle atomization is unstable.	5. Check and repair.
6. Supercharger is surging.	6. Check and wash the air compressor flow passage, clear the fouling, and remove the carbon deposit from the inside of the exhaust turbine.
7. Supercharger bearing is damaged.	7. Replace.

XII. Oil pressure is too low

1. Oil pan oil level.	1. Check the oil level and leakage, and replenish oil.
2. Main oil passage pressure-limiting valve is faulty.	2. Check, wash and repair the valve.
3. Oil anthology cleaner, oil passage, or connector gasket is blocked or fractured.	3. Check oil anthology cleaner and connector gasket, check if there is any foundry fault in oil passage and repair.
4. Oil number does not comply with the specification.	4. Use specified oil.
5. Oil pump inlet pipe leaks.	5. Check, repair or replace oil pipe and connector.
6. Cooling water or oil temperature is too high.	6. Check and repair the cooling system.
7. Oil filter resistance is too big.	7. Replace filter element.
8. Oil cooler is clogged.	8. Check and repair or replace.
9. Main oil passage is blocked.	9. Check and clear.
10. Bearing shell clearance is too big, or damaged.	10. Check and replace.
11. Parts are excessively worn and overhaul is needed.	11. Check the operating hours of the engine, and overhaul.

XIII. Parts wear too fast

1. Air filter element is unqualified or damaged.	1. Check and replace the filter element.
2. Air intake pipe downstream the air filter leaks.	2. Check and repair, or replace the air pipe and sealing gasket.
3. Oil pan is low in oil level or has no oil.	3. Check oil level and leakage, repair and replenish oil.
4. Oil pipeline leaks.	4. Check and repair, or replace the oil pipe and sealing gasket.
5. Oil passage is blocked.	5. Clear the passage.
6. Oil number does not comply with the specification.	6. Use specified oil.
7. Piston ring is fractured or worn.	7. Replace the damaged piston ring.
8. Cylinder liner or piston are worn or scored.	8. Remove, check and repair, or replace the piston and cylinder liner.
9. Oil filter element is not replaced timely.	9. Replace as specified.
10. Parts are excessively worn and overhaul is needed.	10. Check milage, and overhaul if necessary.
11. Crankshaft and its driven shaft are not concentric.	11. Check the mounting bracket and repair.
12. Colt-start liquid is injected too much.	12. Control the amount of each injection.

XIV. Noise is too high

1. Fuel quality is poor	1. Replace fuel.
2. Cooling water temperature is too low.	2. Check thermostat, and replace if necessary.
3. The valve timing or fuel supply timing is incorrect.	3. Check and repair or adjust.
4. Injector is poor in atomization.	4. Check and repair or adjust.
5. Injection pump is too much in pumpage.	5. Check and adjust (by special factory).
6. Shock absorber is damaged.	6. Check if there is any damage and the security of the fastening bolts, and replace damaged parts.
7. Valve leaks or poorly adjusted.	7. Remove, check and adjust the valve.
8. Gear clearance is too big or gear tooth is fractured.	8. Check and replace damaged parts.
9. Cylinder liner or piston are worn or scored.	9. Check and repair or replace.
10. Push rod is bent or fractured.	10. Replace.
11. Piston ring is fractured or worn.	11. Check and replace damaged parts.
12. Bearing shell is worn too much.	12. Check and replace the bearing shell.
13. Crankshaft thrust clearance is too big.	13. Replace the thrust plate.
14. Main bearing shell is eccentric.	14. Check and repair.
15. Crankshaft and its main driven shaft are not concentric.	15. Check the mounting bracket bolts and repair.
16. Parts are excessively worn and overhaul is needed.	16. Check milage, and overhaul if necessary.
17. Supercharger is surging.	17. Clear the fouling from the air passage of the air compressor and the carbon deposit from the exhaust pipe.
18. Supercharger sealing ring is sintered.	18. Replace the assembly.
19. Supercharger bearing is damaged, rotating parts and fixed parts are scuffing with one another.	19. Replace the assembly.
20. Foreign matters entered the supercharger turbine or the air compressing impeller.	20. Replace the assembly.

XV. Injection pump minor failure

Ser. No.	Failure causes	Remedy
1.	No fuel supply: (1) No fuel in the tank. (2) Fuel supply pump does not supply fuel. (3) Fuel filter or fuel pipe is clogged. (4) There is air in the fuel supply system (5) Plunger set is worn. (6) Delivery valve does not close tightly.	1. (1). Refuel. (2) Check and repair fuel supply pump. (3) Wash or replace the fine filter element, and clear the fuel pipeline. (4) Remove air. (5) Replace. (6) Wash, lap or replace delivery valve set, and replace the valve gasket.
2.	Fuel supply is non-uniform:. (1) There is air in the fuel supply system (2) Delivery valve spring is broken. (3) Delivery valve conical surface and pressure relief ring are worn. (4) Plunger spring is broken. (5) There are impurities in the plunger, which jam the movement of the plunger. (6) Fuel supply pump supply pressure is too low. (7) Fuel supply to various cylinders is not adjusted properly.	2. (1) Remove air. (2) Replace spring. (3) Lap or replace. (4) Replace plunger spring. (5) Check and adjust. (6) Check fuel supply pump and fuel filter. (7) Adjust.
3.	Fuel supply is insufficient. (1) Delivery valve leaks fuel. (2) Pipe connector leaks. (3) Plunger set is worn. (4) Incorrect installation.	3. (1) Lap or replace. (2) Check various connectors and repair. (3) Replace plunger set. (4) Reassembly and adjust.
4.	Fuel supply is too much: (1) Fuel injection of the injection pump to various cylinders is not properly adjusted. (2) Incorrect installation.	4. (1) Readjust. (2) Reassembly and adjust.

XVI. Minor failure of injection pump rotating speed

Ser. No.	Failure causes	Remedy
1.	Rotating speed is unstable: (1) Fuel supply to various cylinders is not uniform (2) Fuel injector needle valve injection orifice is clogged by carbon deposit or drips fuel. (3) The weight pin is loose. (4) Plunger spring is fractured. (5) Delivery valve spring is fractured.	1. (1) Rotate the pump body to adjust. (2) Clear the injector needle valve injection orifice or replace needle valve matching parts. (3) Replace pin. (4) Replace. (5) Replace.
2.	Unstable or no idle speed: (1) The throttle control lever is released to its bottom position. (2) Idle speed spring is slightly seized. (3) Rotary sleeve and adjusting pull rod are slightly seized.	2. (1) Check and repair. (2) Check and repair. (3) Check and repair.

Ser. No.	Failure causes	Remedy
3.	Speed fluctuation: (1) Governor spring is deformed. (2) Weight shaft pin is worn and becomes loose. (3) Injection pump rotary sleeve and adjusting pull rod fitting is too loose. (4) Weight opening and closing distances are inconsistent. (5) Fit clearance of the adjusting pull rod, the connecting rod and the adjusting lever pins is too big. (6) Idle speed is improperly adjusted. (7) Sliding shaft and adjusting lever fitting is loose. (8) Governor and injection pump are loosely fit, and the axial clearance of the camshaft is too big.	3. (1) Replace governor spring. (2) Replace shaft pin. (3) Reassembly and adjust. (4) Check and calibrate. (5) Replace pin. (6) Readjust. (7) Check, repair or replace. (8) Tighten the fixing nut, add shims and readjust.
4.	Runaway: (1) High-speed is adjusted too high. (2) Speed adjusting lever pin fell out. (3) High-speed spring is defective or broken. (4) Adjusting pull rod is seized. (5) Adjusting pull rod connecting rod pin fell out. (6) Plunger is seized.	4. (1) Readjust the governor. (2) Repair and reassembly. (3) Repair, reassembly, and adjust. (4) Check and repair. (5) Check and repair. (6) Check and repair.

XVII. Fuel supply pump minor failure

Ser. No.	Failure causes	Remedy
1.	Fuel supply pump does not supply fuel. (1) Fuel supply pump filling valve and delivery valve is damaged or defective. (2) Fuel inlet connector leaks seriously. (3) Plunger spring is broken.	1. (1) Replace. (2) Repair and tighten. (3) Replace.
2.	Fuel supply by supply pump is insufficient: (1) Fuel supply pump filling valve is damaged. (2) Piston is worn. (3) Fuel inlet connector leaks air. (4) Filling valve and delivery valve is not well sealed. (5) Piston spring is poor in spring force.	2. (1) Replace. (2) Replace. (3) Repair and tighten. (4) Lap or replace. (5) Replace.

XVIII. Injector minor failure

Ser. No.	Failure causes	Remedy
1	Too little or no fuel injection: (1) There is air in fuel line. (2) Injector needle valve is seized to valve body. (3) Needle valve and valve body fitting is too loose. (4) Fuel supply system leaks fuel seriously. (5) Fuel supply pump failed to supply fuel normally.	1. (1) Remove air. (2) Wash and repair or replace. (3) Replace injector needle valve matching parts. (4) Repair and tighten various connector bolts. (5) Check and repair fuel supply pump.
2	Low injection pressure: (1) Adjusting screw is loose. (2) Pressure-adjusting spring force is insufficient or broken. (3) Needle valve is poor in sealing.	2. (1) Adjust injection pressure, and tighten. (2) Replace spring and adjust injection pressure. (3) Wash and repair or replace and adjust.

Ser. No.	Failure causes	Remedy
3	Too high injection pressure: (1) Adjustment is improper, pressure-adjusting spring force is too great. (2) There is carbon deposit or dirt in the spray orifice.	3. (1) Readjust injection pressure. (2) Wash or repair.
4	Needle valve matching parts leaks seriously: (1) Pressure-adjusting spring is broken (2) Needle valve matching parts seating face is damaged. (3) Needle valve matching parts are stuck or there is carbon deposit. (4) Needle valve matching parts fitting is loose. (5) Needle valve matching parts fixing sleeve is loose or deformed. (6) Pressure-bearing surfaces of injector body and needle valve are contaminated or deformed.	4. (1) Replace spring. (2) Replace needle valve matching parts. (3) Wash or replace needle valve matching parts. (4) Replace needle valve matching parts. (5) Tighten or replace fixing sleeve. (6) Wash, lap pressure-bearing surface, or replace.
5	Poor atomization, abnormal fuel injection sound: (1) Needle valve body is deformed or worn. (2) Needle valve matching parts fit too tight or is seized. (3) Needle valve matching parts sealing conical surface is worn or burnt. (4) Needle valve matching parts fixing sleeve is deformed.	5. (1) Replace needle valve matching parts. (2) Clean or replace. (3) Lap or replace needle valve matching parts. (4) Replace fixing sleeve.
6	Abnormal diesel fuel injection: (1) Spray orifice is clogged. (2) Needle valve matching parts seating face is excessively worn. (3) Needle valve matching parts are seized or there is carbon deposit.	6. (1) Clean needle valve body. (2) Replace needle valve matching parts. (3) Clean or replace needle valve matching parts. Replace needle valve matching parts. (1) Check and repair cooling system. (2) Reassembly as specified.
7.	Needle valve matching parts surface is burnt or in blue color: (1) Cooling is poor, engine is too hot. (2) Injector is fit improperly, or fixing sleeve is too tight.	

XIX. Starting motor does not operate

1. Battery is undercharged.	1. Check, recharge or replace battery.
2. Connecting wires are in poor contact.	2. Repair and tighten terminal posts.
3. Fuse is burnt.	3. Replace fuse.
4. Brushes are in poor contact.	4. Clean brush surface or replace brushes.
5. Starting motor is shorted.	5. Check and repair motor, or replace motor assy.

XX. Starting motor is not powerful

1. Battery voltage is low.	1. Recharge or replace battery.
2. Bearing bushing is worn.	2. Replace the assembly.
3. Brushes are in poor contact.	3. Clean brush surface or replace brushes.
4. Commutator is dirty or burnt.	4. Clean oil stain and grind the surface by means of sand paper, or replace the assembly.
5. Wire end is unsoldered.	5. Re-solder.
6. Switches are in poor contact.	6. Check and repair.
7. Clutch is worn and slipping.	7. Adjust the clutch working torque, or replace the assembly.

XXI. Generator does not generate electricity

1. Circuit is open or shorted, or connector is loose.	1. Check the wires between the generator and the ammeter, and repair.
2. Rotor or stator coil is open, shorted or grounded.	2. Repair or replace the assembly.
3. Rectifying tube is damaged.	3. Replace the assembly.
4. Terminal post insulation is damaged, or wire is broken.	4. Repair.
5. Voltage regulated by the regulator is too low.	5. Repair.
6. Regulator contacts are burnt.	6. Repair or replace the assembly.

XXII. Generator failed to charge the battery sufficiently

1. Circuit is open or shorted, or connector is loose.	1. Repair.
2. Rotor or stator coil is locally shorted or opened.	2. Repair or replace the assembly.
3. Generator belt is loose.	3. Check and adjust the tension of the belt.
4. Generator rectifier tube is damaged, or brushes are in poor contact.	4. Repair.
5. Voltage regulated by the regulator is too low.	5. Adjust.
6. Regulator magnetic field coil or resistor wire is broken.	6. Repair or replace.
7. Battery electrolyte is insufficient, or battery is aged.	7. Add electrolyte, or replace battery.

XXIII. Charging current is unstable

1. Stator or rotor coil is about to be shorted or broken.	1. Repair or replace.
2. Brushes are in poor contact.	2. Repair.
3. Terminal posts are loose, and in poor contact.	3. Repair.
4. Voltage regulator is damaged.	4. Repair.
5. Voltage is improperly regulated.	5. Check and adjust.

XXIV. Generator over-charges the battery

1. Battery is shorted internally.	1. Repair or replace.
2. Voltage regulated by the regulator is too high.	2. Check and adjust.
3. Regulator is poorly grounded.	3. Repair.

XXV. Generator generates abnormal sound

1. Generator is mounted improperly.	1. Repair.
2. Bearing is damaged.	2. Replace bearing.
3. Rotating part is in contact with the stationary part.	3. Repair or replace.
4. Rectifier tube is shorted.	4. Replace.
5. Stator coil is shorted.	5. Repair or replace.